

## ROCKET ENGINE DESIGN ADAPTED FOR TURBINE POWER

### Description

Clean Energy Systems, Inc. (CES) will adapt a rocket engine design to burn a clean fuel and mix the combustion products with water to produce a hot, high-pressure, steam-saturated gas stream that could power an advanced turbine. The fuel used can be derived from various sources, including coal, natural gas, and "opportunity" fuels, so long as the fuel fed into the gas generator is free of ash. Oxygen can be obtained from air via commercially available cryogenic air separation plants or, in the future, can come from advanced plants using oxygen ion transport membranes that are currently being developed.

### PRIMARY PARTNER

**Clean Energy Systems,  
Incorporated**  
Sacramento, CA

### TOTAL ESTIMATED COST

\$2,655,674

### COST SHARING

DOE	\$1,770,000
Non-DOE	\$885,674

### WEB SITE

[www.netl.doe.gov](http://www.netl.doe.gov)

### Goal

The gas generator is based on technology similar to that used in liquid-fueled rocket engines and is what makes the CES approach so innovative. Power plants can achieve net efficiencies of 60-65 percent when they combine the CES gas generator with advanced steam turbines that are expected to reach temperatures of 2600° F and pressures of about 3,000 psia.

### Benefits

The benefits of the CES approach derive from its use of a novel, very high intensity, combustion system that uses oxygen to burn the fuel. The high-temperature, high-pressure gas produced is composed substantially of steam and carbon dioxide (CO<sub>2</sub>). Thus, liquid water and gaseous CO<sub>2</sub> can be readily separated in a condenser located after the turbine. Most of the water is recycled to the steam generator, and the CO<sub>2</sub> can be marketed or sequestered, if necessary. The energy penalty for sequestration is estimated as 3-10 percent of the plant output power, much less than for sequestration with conventional power plants. No atmospheric emissions are produced from the CES power system.

Another significant benefit is the size and capacity of the CES steam generator. The high intensity combustion process, inherent in this steam generator, can effectively produce steam quantities usually generated in a large conventional boiler system. The CES steam generator required for a 400 megawatts power plant is so compact that it could sit atop an office desk while the conventional boiler-type steam generator is the size of a building. The tremendous reduction in size is expected to result in capital costs reductions. For example, the capital costs of a natural-gas-fueled 400 megawatts CES plant, based on near-term technology, is estimated to be 20 percent less than a similar sized gas-fired turbine combined cycle power plant. Coal-fueled CES plants are also expected to have lower capital costs than competing integrated gasification combined cycle (IGCC) plants.



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## CONTACT POINTS

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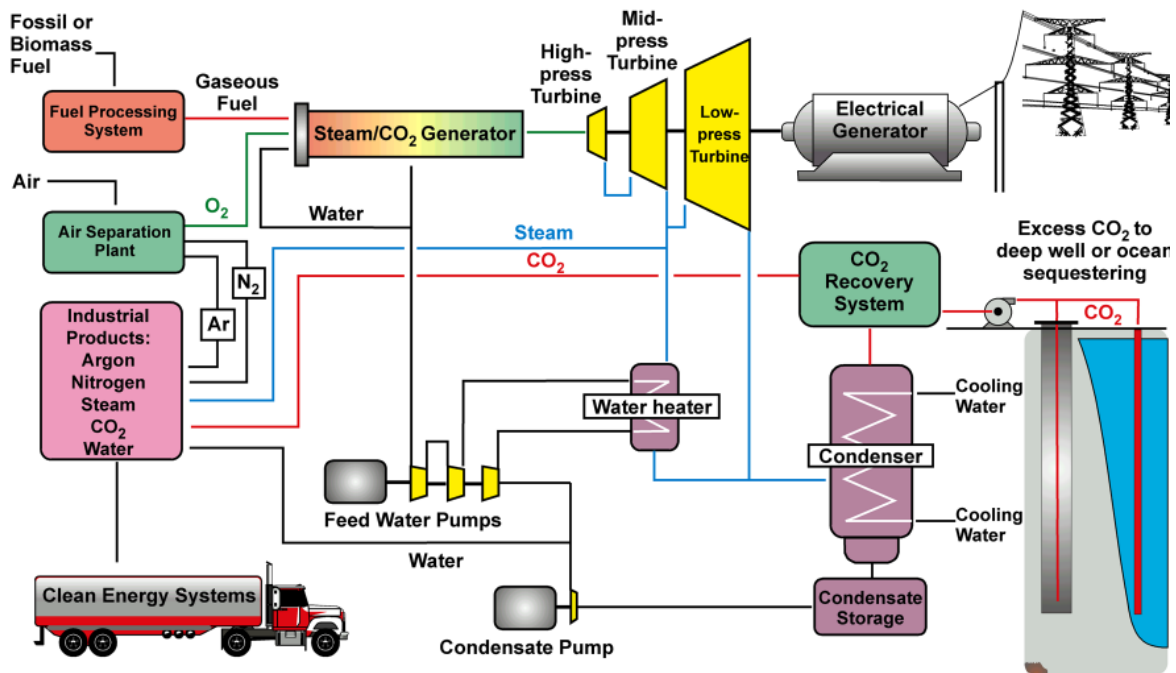
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## Milestones

This is a 24-month cooperative agreement.

Initiate Project	June 2000
Complete Detail Design of the Gas Generator	September 2000
Complete Fabrication of the Gas Generator	March 2001
Complete Testing of the Gas Generator	March 2002
Deliver Final Report	June 2002

## The CES Power System



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